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African easterly waves and their association with precipitation

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[1] Summer tropical synoptic-scale waves over West Africa are quantified by the 850 mb meridional wind component from the National Centers for Environmental Prediction/National Center for Atmospheric Research reanalysis project. Their relationships with surface precipitation patterns are explored by applying the data from the Tropical Rainfall Measuring Mission satellite in combination with other satellite observations during 1998–2002. Evident wavelet spectral power peaks are seen within a period of 2.5–6 days in both meridional wind and precipitation. The most intense wave signals in meridional wind are concentrated along 15°N–25°N. Wave signals in precipitation and corresponding wavelet cross-spectral signals between these two variables, however, are primarily located at 5°N–15°N, the latitudes of major summer rain events. Southerly wind perturbations tend to lag (lead) precipitation signals south (north) of 15°N. In some cases either an in-phase or out-of-phase relationship can even be found, suggesting two distinct relationships between the waves and convection. Moreover, the lagging relationship (and/or the out-of-phase tendency) is only observed south of 15°N during July–September, indicating a strong seasonal preference. This phase relationship is generally consistent with the horizontal wave structures from a composite analysis. *INDEX TERMS:* 3314 Meteorology and Atmospheric Dynamics: Convective processes; 3354 Meteorology and Atmospheric Dynamics: Precipitation (1854); 3374 Meteorology and Atmospheric Dynamics: Tropical meteorology; *KEYWORDS:* African easterly waves, tropical convection

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1. Introduction

[2] Westward propagating synoptic-scale waves over West Africa, commonly called African easterly waves (AEWs), are important weather phenomena during the boreal summer. They can organize and effectively modulate precipitation over the western African continent, and occasionally evolve into tropical cyclones under certain favorable circumstances when they move into the Atlantic Ocean [e.g., *Carlson*, 1969a, 1969b; *Burpee*, 1972, 1974, 1975; *Reed et al.*, 1977].

[3] Various surface and upper air data, particularly the data from the Global Atmospheric Research Program (GARP) Atlantic Tropical Experiment (GATE), and satellite InfraRed (IR) observations have been widely applied to extract synoptic-scale wave signals and to characterize their spatial structures through spectral and composite analyses, respectively [e.g., *Burpee*, 1974; *Reed et al.*, 1977; *Duvel*, 1990]. Generally encompassing a period of 3–8 days, these synoptic-scale waves propagate westward at a speed of 5–10 m s^{-1}, yielding a wavelength on the order of 1000–5000 km. Maximum wave amplitude is in the meridional wind component and located in the 850–650 mb layer [e.g., *Burpee*, 1972; *Reed et al.*, 1977]. These waves are fed mostly by the African Easterly Jet (AEJ) through combined barotropic and baroclinic energy conversions [e.g., *Burpee*, 1972]. Their structures and particularly their relations with cloudiness and/or precipitation are emphasized [e.g., *Carlson*, 1969a, 1969b; *Burpee*, 1974; *Reed et al.*, 1977; *Chen and Ogura*, 1982; *Duvel*, 1990; *Diedhiou et al.*, 2001]. It is generally found that two perturbation centers are actually associated with these waves. (1) One is south of about 10°N and always accompanied by moist convection. Maximum northerly and southerly wind components in the lower layer occur before and after the wave trough, respectively. Most intense upward motions occur within, and somewhat ahead of the wave trough (corresponding to the intense convergence near the surface), where maximum precipitation is generally observed. Weakest precipitation is found in and ahead of the wave ridge. (2) The second center of wind perturbation is located between 10°N–20°N, not necessarily with precipitation or even cloud. Most precipitation events occur in the

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